

PEEMVision

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Introduction

PEEMVision is the data acquisition and analysis program for the PEEM-3 microscope at the Advanced Light Source. It is written in the IDL programming language and requires the IDL virtual machine to run. Updates will be regularly posted on the PEEM-2 web page:

<http://xraysweb.lbl.gov/peem2/PEEM2-02.html>

System Requirements

Any newer Windows PC will do. At least 5 GB HD space are needed for temporary storage. Because of the large image size, execution is throttled by the speed of the HD if temporary images need to be off loaded to disk.

Tested with Windows 2000, XP, Vista, Windows 7 (64 bit). Using Windows classic mode helps if UI elements overlap. There is also a selector in the Preferences that adjusts the thickness of window frames. The latest version requires the IDL Virtual Machine 8.3. An older version for IDL 7.1 is also available.

Installation

Install the IDL development system or the IDL Virtual Machine. The IDL VM can be downloaded from Exelis. Please follow this link to the manufacturer web page:

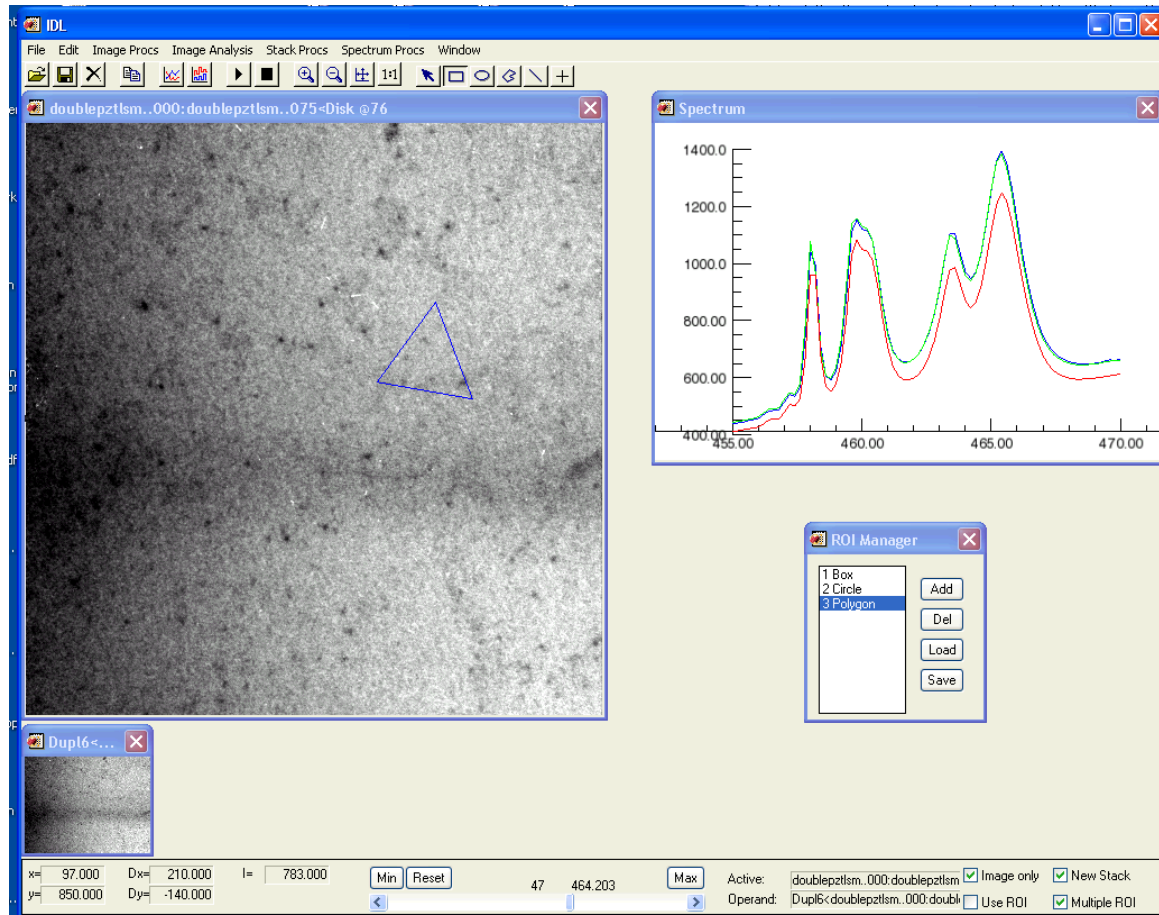
<http://www.exelisvis.com/ProductsServices/IDL.aspx>

Download of the run time environment is free but requires an account with Exelis. A developer's license requires purchase.

Refer to the IDL documentation for help with the installation of IDL. Unzip PEEMVision.sav and the *.bmp files into the same folder. Start the program by double-clicking PEEMVision.sav. The IDL Virtual Machine will start automatically. Opening PEEMVision.sav using the Virtual Machine "Load File" dialog box breaks the links to external bitmaps. As a consequence buttons may be missing.

Camera, display and communication preferences are changed using the File/Preferences menu option. Note that some values for the heap memory and the display parameters could lead to system crashes.

Graphical User Interface (GUI)



The GUI is arranged Windows style, a menu bar and a tool bar at the top, and a status bar at the bottom. These bars are glued to the outside of the window and will move with the main window. The active stack/image appears in the top left corner of the gray canvas, while the associated spectrum is shown on the top right corner. One stack/image is shown full size while other images are shown iconized and glued to the bottom above the status bar. Only one image is displayed at full size but the size of the iconized images can be adjusted in the program preferences. Since IDL doesn't support a standard windows environment, the simulated windows environment will feel different from conventional "Windows". Stacks and spectra can be closed by using the "Close" button. The Zoom functions allow zooming into smaller areas within the image or spectrum.

The Stack Concept

Images are arranged in containers called stacks, which represent a series of images acquired as function of a changing variable, e.g., photon energy. A stack can contain a single image or a series of images and it is limited in length only by computer resources and disk space. These images are stored in permanent or temporal disk files and/or, up to a user defined limit, in a RAM for faster processing. The limit can be set to 0 MB (the default) in order to enforce using the hard disk. Using this option slows down image processing but reduces usage of computer RAM and helps with program stability. When

initially opened, stacks are never directly transferred into memory. Loading will occur when the individual images are either viewed or processed for the first time. Do not manually erase images on disk while they are open in PEEMVision because this will corrupt file access and lead to program errors and crashes.

Spectra are associated with stacks and contain either image intensities in user selected areas as function of image number/photon energy, etc., or the result of image processing functions such as histograms, line profiles, and power spectra. Spectra are saved separately from stacks and will not be automatically saved when the associated stack is saved.

Many additional parameters, including photon energy, position, and acquisition parameters are stored in P3B formatted image files. This information will be lost when converting images into TIFF or JPG format.

Status Bar

Cursors and Intensities

The cursor position, length of the last cursor step, for example, while defining a region of interest (ROI), and the intensity at the cursor position are shown on the left side of the status bar. Moving the cursor across an image will update the cursor position and update the display of the local image intensity. Pushing the left mouse button sets the first and subsequent corners of a region of interest and will initiate update of the cursor step display. The right mouse button will close a polygon area. If a preview is running, defining a rectangular ROI will enable the preview intensity display in the top right corner, which is being updated while the preview updates..

Image Slider Bar

The image slider bar allows stepping through an image stack, image by image. The Min and Max buttons redefine the range of images in the stack that are being used in stack operations. The Reset button resets the range to the full range. The image number, starting at 1 and the image x-position, usually the photon energy, are displayed above the image slider.

Indicators and Switches

The names of the “Active” and the “Operand” stacks, are shown on the left side of this area. The “Active” stack is shown magnified on the canvas while the “Operand” stack and all other stacks are iconized at the bottom of the canvas. All operations act on the “Active” stack. The Operand stack is used in operations that require two input stacks. Four checkboxes modify the behavior of many functions of the program:

Image Only

By default, many functions will be applied sequentially to all images of a stack. Checking this box will apply a function to only the currently displayed image.

New Stack

By default, the result of an operation will overwrite the active stack. A temporary stack will be discarded while a stack saved on disk will be dropped from memory. Checking the box will keep the source stack and the resulting stack will be added to the list of open stacks.

Use ROI

By default, many operations will be performed on the whole image. Checking the box will perform an operation on a region of interest (ROI).

Multiple ROI

By default operations that require a region of interest (ROI), are performed within the currently ROI. Checking the box will apply the operation to multiple ROI's defined in the ROI window.

Tool Bar

The tool bar contains buttons grouped by functionality: Stack tools, Copy/Paste tools, Operations tools, Movie tools, Zoom tools, Cursor tools, and the Camera group. The camera group is only visible if CCD hardware is found.

Stack tools

Load stack

Asks for a filename and loads a new stack from disk

Save stack

Asks for a filename and saves a stack to disk. If the stack that is being saved is not a temporary stack then the function basically acts like "Save As" and a copy of the stack is created.

Close stack

Closes a stack

Copy/Paste tools

Copy image

Copies the currently active image or spectrum to the clipboard. From there it can be pasted into other programs that can display bitmaps.

Operations tools

Calculate spectrum

Calculates an (energy spectrum) in one or multiple ROIs.

Calculate histogram

Calculates an image histogram.

Movie tools

Start

Plays a stack as movie. The movie runs continuously and rewinds automatically

Stop

Stops movie playback or interrupts image operations.

Zoom tools

Zoom in

Uses the currently defined ROI and magnifies the image/spectrum such that it fills the window. The resulting image may be distorted.

Zoom out

Demagnifies the stack by 2. Does not operate on spectra.

Reset zoom

Resets the zoom so that the image/spectrum fills the window.

Zoom 1:1

Restores an aspect ratio of 1:1 after a zoom operation. Does not operate on spectra.

Cursor Tools

Arrow

Selects a stack or spectrum window without any other effect.

Box

A rectangular ROI is selected using the mouse. Two mouse clicks set the area of interest. This tool works in images and spectra.

Ellipse

An elliptical ROI is selected using the mouse. Two mouse clicks set the area of interest. This tool only works in images.

Polygon

A polygon ROI is selected using the mouse. Left mouse clicks set corners and a right mouse click closes the polygon. This tool only works in images.

Line

The line tool draws a line using two mouse clicks for the start and end point. Line spectra, Skew operations and Rotations make use of the Line tool. This tool only works in images.

Marker tool

Used in a stack window, the marker tool sets an alignment mark for manual alignment of images. Used in a spectrum window, the image slider of the associated stack is moved to the position in the stack marked by the cursor.

Menus

File

The file menu contains input/output functions.

Load

Loads an image or a stack from disk. A stack can be loaded either from a multiple image file or from a selection of files. Single image files and multiple image files can be mixed. The image type, image dimension, and bit depth must be the same for all images. The following image formats are supported:

P3B	Standard binary format for data exchange at PEEM2/3. Floating point and 8/16/32 bit integer formats are permitted.
TIFF/TIF	Single and multiple image files. Floating point and 8/16/32 bit integer formats are permitted. The reader also reads 12 bit TIFF from a Photonic Sciences camera and converts them to 16 bit.
JPEG/JPG	Standard 8 bit compressed JPEG images.
JPEG2000, JP2	Reads compressed and not compressed 8/16 JPEG2000 images.
GIF	Reads compressed 8bit multi image GIF files (movies).
LVB	Binary format used by the BL4/11 streak camera experiment.
XIM	Text format used by scanning and transmission microscopes.
TXT	Simple text format.
PNG	Special Swiss Light Source PNG format.
SPE	Princeton Instruments SPE binary format.

Multiple images are selected using the standard CNTR+Mouse-click and SHIFT+Mouse-click procedures¹ or by selecting multiple images by drawing the mouse. CNTR+A selects all images in a folder.

Save As

Saves images in a user selectable image formats. The default can be selected in the Preferences window. Usually the function defaults to the P3B format. Only a subset of file formats is permitted for writing:

¹ The last image of the stack has to be selected first and the first image last to open images in the correct order.

P3B	Standard binary format for data exchange at PEEM2/3. Floating point and 8/16/32 bit integer formats are permitted.
TIFF/TIF	Stacks are saved as multiple image files. Floating point and 8/16/32 bit integer formats are permitted. Images can optionally be compressed using a loss-less LZH algorithm. Compression options are selected in the Preferences window.
JPEG/JPG	Standard 8 bit compressed JPEG images. All other bit formats are converted to 8 bit.
JPEG2000, JP2	Writes images as JPEG2000 files. The images are compressed either a lossless or a lossy algorithm. Compression options are selected in the Preferences window.
GIF	Writes compressed 8 bit multi image GIF files (movies). All other bit formats are converted to 8 bit.
LVB	Binary format used by the BL4/11 streak camera experiment.
XIM	Text format used by scanning and transmission microscope.
TXT	Simple text format.

Close

Closes the current stack.

Close All

Closes all stacks.

Save Spectrum

Saves the spectra associated with an image stack.

Export Tags

Exports selected (P3B) image parameters into a text file.

Preferences...

Opens a dialog box to set user preferences. These preferences are automatically stored between sessions and most require a manual restart of the program.

- File/Format: Chooses the default file format. P3B is recommended to preserve additional information saved in the images
- File/Heap: Use (MB) Amount of RAM used for image storage. By default images are exclusively saved on HD. Ensure that this number is ~1GB less than the available physical memory.
- File/Compressed: Toggles compression for TIFF and JPEG2000 formats. JPG is always compressed, P3B is never compressed.
- File/Multiple Pages: If enabled, multiple image stacks will be saved in a single file (TIFF/GIF format only)
- Camera/Server IP: IP address of the data acquisition server (usually a Labview program)
- Camera/Command Port: The command port address of the acquisition server
- Camera/Status Port: The status port address of the acquisition server.
- Camera/Cooling: Turns camera cooling on/off (Restart required)

- Camera/Camera DLL: Path to the camera DLL (Scientific Instrument type)
- Camera/Flatfield Directory : Path to Flatfield images
- Camera/Data Directory: If used, path to the data directory
- Display/Window Style: Old Style – Win2000, New Style – Win XP
- Display/Renderer: Software is safer, Open GL is faster
- Display/Rotate Camera: Image orientation
- Display/Icon Size: Size of the preview images.

About...

About this program.

Edit

The edit menu contains image copying and transformation functions.

Copy

Copies an image or spectrum to the clipboard.

Duplicate

Duplicates an image or a stack. The function uses the current ROI if the “Use ROI” checkbox is checked (crop). The function processes the currently displayed image out of a multi-image stack if the “Image only” checkbox is checked, otherwise it operates on the whole stack. If an image range is selected only this subset of images is processed.

Delete

Deletes a subset of images from a stack. The subset is selected using the image range tools. If “Image only” is checked, it will remove the currently selected image, ignoring the range setting.

Convert

Converts a stack to a different bit format. Choose between 8-bit, 16-bit, 32-bit and single precision floating-point. The function uses the current ROI if the “Use ROI” checkbox is checked. The function processes the currently displayed image out of a multi-image stack if the “Image only” checkbox is checked. If an image range is selected only this subset of images is processed. No scaling is done, potentially leading to information loss when chooses a lower bit depth.

Delete Marker

Deletes the mark indicator in the current image. Markers are used for manual alignment and defined using the marker (cross) tool.

Delete All Markers

Deletes all markers.

Set X Column

Chooses a different parameter as the abscissa in spectrum plots. The data acquisition software sets the default.

Set Box

Define the boundaries of a rectangular ROI by their coordinates. The full image is the default.

Image Procs

Rebin

Opens a dialog box for re-binning an image or stack. In contrast to the “Resize” function “Rebin” does not simply resample the image. Instead it will group and average pixels in the image if the image is deflated in size and it will interpolate if the image is expanded in size. Orphaned pixels at the image boundary will be discarded. The function processes the currently displayed image out of a multi-image stack if the “Image only” checkbox is checked. If an image range is selected only this subset of images is processed.

Resize

Opens a dialog box for resizing an image or stack. The function processes the currently displayed image out of a multi-image stack if the “Image only” checkbox is checked. If an image range is selected only this subset of images is processed.

Rotate

Opens a dialog box to rotate a stack. You can use the Line tool beforehand to define an arbitrary angle interactively. A structure aligned with the line will be horizontal after the rotation. Rotate keeps the image size constant. Alternatively, fixed angle rotation and mirror operations can be selected. The 90° and 270° rotations exchange the horizontal and vertical image dimensions. This function uses the current ROI if the “Use ROI” checkbox is checked. The function processes the currently displayed image out of a multi-image stack if the “Image only” checkbox is checked. If an image range is selected only this subset of images is processed.

Skew Horizontal

Skews an image horizontally. Use the line tool to define the line/angle that will be tilted to the vertical. This function uses the current ROI if the “Use ROI” checkbox is checked. The function processes the currently displayed image out of a multi-image stack if the “Image only” checkbox is checked. If an image range is selected only this subset of images is processed.

Skew Vertical

Skews an image vertically. Use the line tool to define the line/angle that will be tilted to the horizontal. This function uses the current ROI if the “Use ROI” checkbox is checked. The function processes the currently displayed image out of a multi-image stack if the

“Image only” checkbox is checked. If an image range is selected only this subset of images is processed.

Parabolic Flatten

Fits a 2nd order polynomial (parabola) to the intensity distributions in the vertical and horizontal direction and normalizes the image by those polynomials. This function is useful to remove the effect of an inhomogeneous illumination. Applied to integer images, the function shifts the average image intensity to the center of the number range (32768 for an unsigned integer image). This function uses the current ROI if the “Use ROI” checkbox is checked. The function processes the currently displayed image out of a multi-image stack if the “Image only” checkbox is checked. If an image range is selected only this subset of images is processed.

Polynomial Flatten

A dialog box is opened to select polynomial order and repetition factor. Fits nth order polynomials to the intensity distributions in the vertical and horizontal direction and normalizes the image by those polynomials. This function is useful to remove the effect of an inhomogeneous illumination. Applied to integer images, the function shifts the average image intensity to the center of the number range (32768 for an unsigned integer image). This function uses the current ROI if the “Use ROI” checkbox is checked. The function processes the currently displayed image out of a multi-image stack if the “Image only” checkbox is checked. If an image range is selected only this subset of images is processed.

Normalize to Horiz.

A horizontal profile is calculated over the whole image if “Use AOI” is not selected, or over a rectangular area, stretching from the left of the image to the right and limited in height by the height of the current AOI. This line profile is then used to scale the image intensity column-by-column. Note that this routine only works properly for floating point images. Some scaling will likely be necessary to shift the pixel intensities to a viewable range. The function processes the current image, if “Image only” is selected. If an image range is selected only this subset of images is processed.

Normalize to Vert.

A vertical profile is calculated over the whole image if “Use AOI” is not selected, or over a rectangular area, stretching from the top of the image to the bottom and limited in width by the width of the current AOI. This line profile is then used to scale the image intensity row-by-row. Note that this routine only works properly for floating point images. Some scaling will likely be necessary to shift the pixel intensities to a viewable range. The function processes the current image, if “Image only” is selected. If an image range is selected only this subset of images is processed.

Normalize to I0

Divides each image of a stack by the I0, stored as an image tag. This function does nothing if no I0 was stored. The function processes the current image, if “Image only” is selected. If an image range is selected only this subset of images is processed.

Normalize to Average

Divides each image of a stack by its average intensity or the intensity in a selected area, if “Use ROI” is toggled. The function processes the current image, if “Image only” is selected. If an image range is selected only this subset of images is processed.

Smooth

Applies a Smooth filter with radius 3 to the current stack. The function processes the current image, if “Image only” is selected.

Median

Applies a Median filter with radius 3 to the current stack. The function processes the current image, if “Image only” is selected.

Lee

Applies a Lee filter with radius 3 to the current stack. The function processes the current image, if “Image only” is selected.

Image Analysis.

Calc Spectrum (ROI)

Calculates spectra from one or multiple areas (Multiple ROI toggled) of a stack. The result is displayed in a spectrum window and can be saved using Save Spectrum in the File menu. An image with superimposed ROI boundaries is automatically posted on the clipboard. If an image range is selected only this subset of images is processed.

Calc Spectrum (Mask)

Calculates spectra using a mask image or stack (the operand). The mask image/stack has to be of unsigned short (byte) format and can be generated using the Apply function of the contrast window. Logic functions can be used to generate multiple mask images. The mask stack can consist of multiple images, resulting in multiple spectra, one per mask image. Only non-zero pixels in the mask image contribute to the spectrum. The result is displayed in a spectrum window and can be saved using Save Spectrum in the File menu. If an image range is selected only this subset of images is processed.

Line Profile

Calculates one line profile per image of a stack and displays it in the spectrum window. The line is defined by the Line tool. The function processes the current image, if “Image only” is selected. If an image range is selected only this subset of images is processed.

Horiz. Profile

Calculates an intensity profile in a rectangular area and displays it in the spectrum window. The width of the rectangle determines the length of the profile. The height determines the length across which pixels are being averaged. The function processes the current image, if “Image only” is selected. If an image range is selected only this subset of images is processed.

Vert. Profile

Calculates an intensity profile in a rectangular area and displays it in the spectrum window. The height of the rectangle determines the length of the profile. The width determines the length across which pixels are being averaged. The function processes the current image, if “Image only” is selected. If an image range is selected only this subset of images is processed.

Histogram

Calculates the histogram within a rectangular area, either the whole image or, if “Use ROI” is toggled, a rectangular ROI. The function processes the current image, if “Image only” is selected. If an image range is selected only this subset of images is processed.

PowerSpectrum

Calculates a one-dimensional power spectrum of the Fourier transform of an image or a stack.

FFT

Calculates real and imaginary Fourier transform images/stacks.

Image Statistics

Displays pixel count, total count rate, maximum, minimum and average intensity, sum of squares, variance.

Stack Procs

Explode

Explodes a multiple image stack into multiple single image stacks. The number of images is limited to 20.

Combine

Combines two stacks into a single stack. This function uses the current ROI if the “Use ROI” checkbox is checked. It combines single images of the two stacks if the “Image only” checkbox is checked. The image size and pixel depth of both stacks must be the same.

Sort (ABAB)

Averages all odd and all even images of a stack and generates a new stack containing the two averaged images.

Sort...

Sorts and averages stacks using a sort pattern defined in a dialog box. “# Elements” specifies the number of distinct elements in the pattern. For example, the following pattern has three elements: ABCABC. Block Size specifies the size of a block of similar images. For example, the following pattern has blocks of 2: AABBBCCAABBCC. The “ABCCBA Pattern” checkbox reverses the order of elements for every period. The “Sort”

option sorts all A images, B images, C images, etc. into multiple image A, B, C stacks. The “Average” option averages all A, B, C, etc., images into one new multiple image stack. The “Sum” option is similar to the “Average” option but the added image intensities are not divided by the number of images. All integer formats are converted into signed long (32bit).

Tile...

Arranges a multiple image stack into a tiled image. Row number, column number, orientation, frame and shrinkage factor are selectable.

Align

Automatically aligns a stack using a search algorithm based on maximizing the cross-correlation function between the first image and the other images of a stack. A rectangular ROI has to be selected in the first stack image. The ROI should enclose a strong image feature that appears with similar contrast in all images, for example a dust particle. The algorithm can fail if the contrast is too weak or the motion between images is too large. If aligning fails, choosing a different ROI sometimes helps. Otherwise use “Mark Align”. Checking the “Multiple ROI” toggle will attempt a multiple area align/warp of the images of a stack using the ROIs listed in the ROI manager. The function will use a least square fit algorithm to determine, translation, rotation, and skew to optimally align multiple regions of the images. If the images after an align look “weird” check whether “Multiple ROI” was toggled.

Align 4x Oversampling

Same as align but accuracy is increased by a factor of 4 by oversampling the images during the alignment. This routine is much slower and will likely not work as well if images are noisy and image drift is rapid.

Align Horizontal

Similar to the “Align” function but limiting the optimization to horizontal translations.

Align Vertical

Similar to the “Align” function but limiting the optimization to vertical translations.

Mark Align

Aligns a stack using manually placed markers. Markers are set using the “Mark” tool. This function shifts all images such that the alignment markers fall on top of each other. If an image does not contain a marker, the function linearly interpolates between the closest marker positions. Markers must be set in the first and the last image of a stack and before and after a large jump.

Spectrum Procs

Spectrum to Image

Creates an image from multiple spectra by assembling the image, row-by-row using the spectrum intensities..

Scan Horizontal

Creates multiple spectrum displaying the intensity of an image row-by-row.

Scan Vertical

Creates multiple spectrum displaying the intensity of an image column-by-column.

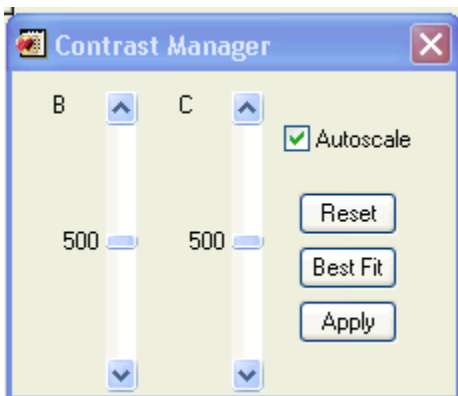
Window

ROI Manager



Stores multiple ROIs for spectrum analysis and stack alignment. ROIs. The “Multiple ROI” toggle determines whether the current ROI in the active image or ROIs listed in the ROI Manager will be used in an operation. ROIs can be saved and loaded.

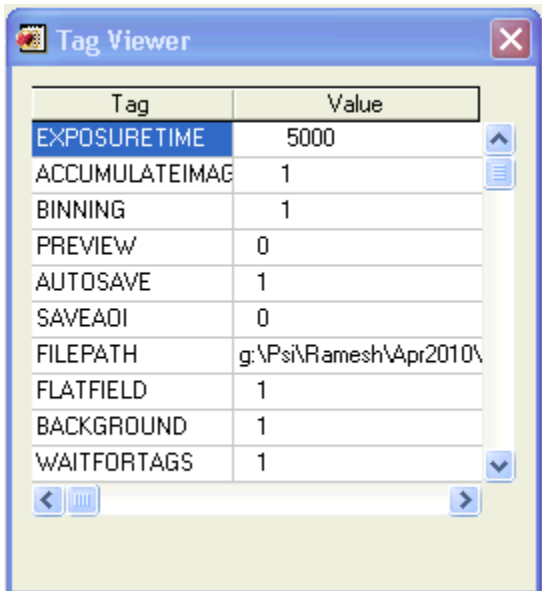
Contrast



Adjust brightness (B) and contrast (C) of an image or use Autoscaling, if selected. Reset the contrast, automatically optimize the contrast using “Best Fit” or create an 8 bit depth

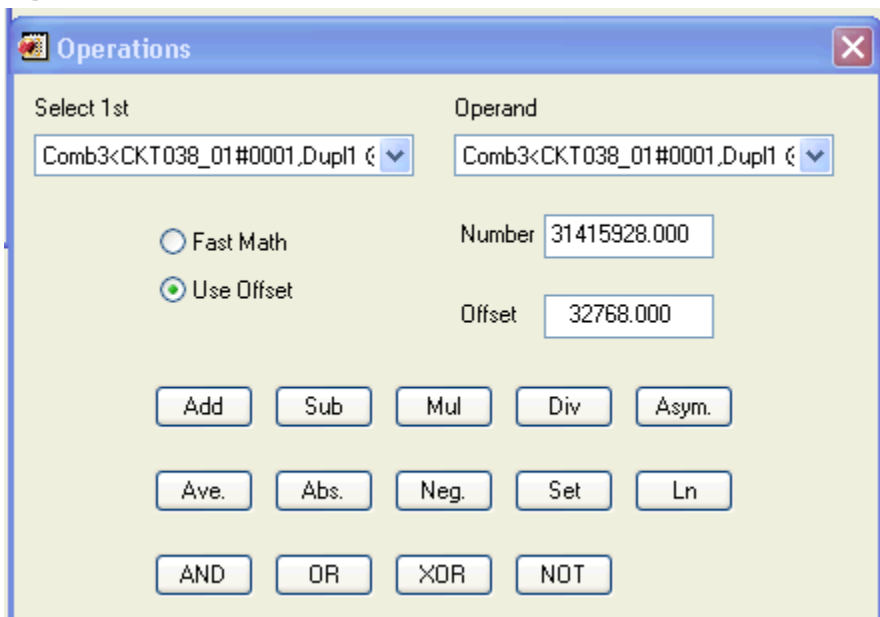
image using “Apply”. 8 bit images are ideal for saving as a JPG or to use as mask image for spectrum analysis.

Tag Viewer



Images saved as P3B images or images acquired using the acquisition software (except Preview images), contain additional information about the beamline and experiment status.

Operations



Perform numerical or logical operations using image stacks and numbers. Stacks either need to have the same number of images or one of them needs to contain a single image. If both stacks have more than one image then operations are performed image-by-image. If one operand is a single image stack or a number then this image/numbers is used in the

computation of all images in the multiple image stack. The two operands are selected using the two drop down lists or by left-clicking stack icons. Images in both stacks have to be of the same size and type. A number can be used as the second operand. Select “Use Number” as the 2nd operand and enter a value in the Number box.

The routine will compute the differential of consecutive images if the same stack is used for both operands. For example, the operation “Sub” will subtract the 2nd image from the 1st, the 3rd from the 2nd, the 4th from the 3rd ...

If the Fast Math checkbox is selected, all operations perform without using offsets or scaling. If “Use Offset” is selected, the result of an operation is scaled or shifted using the offset. This is very useful for Integer operations but undesirable for Floating Point operations.

The following calculations are performed before a binary image operation:

I1, I2: Images are cast to floating point before operation and cast back to the original type at the end of the operation.

Offset: The offset is set in the “Offset” text box. The default is 32768 for a 16 bit TIFF image.

Some examples of binary operations (using the offset):

Add: $I1 * scale + I2 - offset$

Sub: $I1 * scale - I2 + offset$

Mul: $I1 * scale * I2 / offset$

Div: $I1 * scale / I2 * offset$

Asym: $((I1 * scale - I2) / (I1 * scale + I2) + 1.0) * offset$

Filters



Applies a standard “Smooth”, “Median”, or “Lee” filter to the image. The Kernel size and repetition can be selected. The filters are discussed in the IDL documentation.

'P3B' data stream and file type

P3B encodes tagnames and tagvalues as binary values. It is meant to store one 2D image plus additional information but is sufficiently flexible to save and load almost any structure type variable.

General structure

Long	Number of tags (tnum)
TagType[0..tnum-1]	Data

Tag structure

Long	Length of tag name in characters.
String	Tag name
Long	Data type (uses IDL type codes)
Long	Data length (either number of characters if string type or number of data elements if numerical type)
String or Data[0..length-1]	String or data array.

Supported data types and type codes

Type Code	Type Name	Data Type
1	BYTE	Byte
2	INT	Integer
3	LONG	Longword integer
4	FLOAT	Floating point
5	DOUBLE	Double-precision floating
6	COMPLEX	Complex floating
7	STRING	String (no arrays!)
9	DCOMPLEX	Double-precision complex
12	UINT	Unsigned Integer
13	ULONG	Unsigned Longword Integer
14	LONG64	64-bit Integer
15	ULONG64	Unsigned 64-bit Integer

If used to store 2D images the three first tags should be:

Long	DimX
Long	DimY
Long	PixType

This ensures that a program can read the image format and prepare the internal data structure without reading the whole file.

TCP Communication

The program connects to a server via TCP/IP. The server controls the image acquisition remotely. Two ports are used: by default port 30001 for receiving commands from the server and port 30002 for sending status information. Port 30001 is constantly polled for new commands.

List of commands

WR_SCN	Write scan parameters.
RD_SCN	Read scan parameters
INISCN	Init scan.
ENDSCN	End scan.
WR_IMT	Write image tags.
ACQUIR	Acquire.
CR_LOG	Requests creation of a log file.

A command is a 6 character string or byte array, which is send without preceding length information. After the command can follow a binary data structure that is identical to the P3B data format.

Command WR_SCN

A data structure is expected that contains the exposure parameters.

struct = { ACQPARAMS, ExposureTime: 0UL, Binning: 0U, Preview: 0B, \$
AutoSave: 0B, SaveAOI: 0B, FilePath: "", Flatfield: 0B, Background: 0B }

ExposureTime	Time in milliseconds.
Binning	1,2, or 4 for 1x1, 2x2 or 4x4 binning
Preview	0: Image or stack acquisition: The acquisition command causes a single image to be acquired. 1: Preview: Bypasses some of the image processing. The acquisition command starts a running preview.
AutoSave	0: Images are retained in memory or a temporary file. 1: Images are being saved using the supplied file path.
SaveAOI	0: The whole image is being saved. 1: Only a subset of the image is being saved. The area of interest is selected using the box tool in <i>PEEMVision</i> .
FilePath	The path to the destination file location.
Flatfield	Causes a new image to be divided by a flatfield image.
Background	Causes acquisition of a background image during scan initialization which is being subtracted from all acquired images.
WaitforTags	0: Acquisition ends with waiting for image tags (used for preview) 1: Acquisition waits for tags.

Returned status:

Code: 0 Message 'Parameters received'

Command RD_SCN

A data structure is returned that contains the exposure parameters.

struct = { ACQPARAMS, ExposureTime: 0UL, Binning: 0U, Preview: 0B, \$
AutoSave: 0B, SaveAOI: 0B, FilePath: "", Flatfield: 0B, Background: 0B }

Returned status:

Code: 0 Message 'Parameters sent'

Command INISCN

Initializes the camera using the previously sent scan parameters. A background image is acquired, if the 'Background' flag is set. A stack structure is prepared in *PEEMVision* that will receive the images.

Returned status:

Code: 0 Message 'Scan initialized'

If a background image is being acquired this response is preceded by the following messages:

Code 0 Message 'Acquisition started'

Code 1 Message 'Readout started'

Code 0 Message 'Acquisition complete'

Command ENDSCN

Completes the spectrum acquisition. If a preview is running, this command ends the preview remotely. If spectra are being generated, the spectrum file is saved to disk.

Returned status:

Code: 0 Message 'Scan ended'

Command WR_IMT

A data structure is expected that contains additional image tags. This command should be sent by the server right after the readout started but before the acquisition is complete. Timing is critical, if Flag 'WaitforTags' is not used. Depending on binning the server has about 100-300 ms to send the image tags. It will (indefinitely) if 'WaitforTags' is used. The binary data structure should have the form of a P3B stream. Any tags will be accepted and saved in the image.

Command ACQUIR

If the 'Preview' flag was set a running preview is started, otherwise a single image is being acquired and added to the stack. If image tags were received from the server they will be included into the image.

Returned status:

Code 0 Message 'Acquisition started'

Code 1 Message 'Readout started'

Code 0 Message 'Acquisition complete'

Command CR_LOG

A data structure is expected that contains the path to the log file..

struct = {LOGPARAMS, LogPath: ""}

LogPath The name/path of the log file.

Returned status:

Code: 0 Message 'Parameters received'

Status messages

Status messages are returned during and after the completion of commands.

Structure

Long	Code
Long	String length
String	Message

Error messages are indicated by a negative value for 'Code'. The message provides further information. An error message indicates that the command has been aborted. Informational messages possess a zero or positive 'Code' value.

Messages

Code	Message
0	'Parameters received'
0	'Parameters sent'
0	'Scan initialized'
0	'Scan ended'
0	'Acquisition started'
1	'Readout started'
0	'Acquisition complete'

Communication examples

Preview

Command	Parameters	Wait for message
WR_SCN	ACQPARAMS	'Parameters received'
INISCN		'Scan initialized'
ACQUIR		'Acquisition complete'
...Preview running.		
ENDSCN		'Scan ended'

Stack (no x-ray shutter)

WR_SCN	ACQPARAMS	'Parameters received'
INISCN		'Scan initialized'
ACQUIR		'Readout started'
WR_IMT	P3B Stream	'Acquisition complete'
ACQUIR		'Acquisition complete'
WR_IMT	P3B Stream	'Acquisition complete'
...		
ACQUIR		'Acquisition complete'
WR_IMT	P3B Stream	'Acquisition complete'
ENDSCN		'Scan ended'

Stack (x-ray shutter)

WR_SCN	ACQPARAMS	'Parameters received'
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Close shutter for background acquisition if not already closed.		
INISCN		'Scan initialized'
Open shutter.		
ACQUIR		'Readout started'
Close shutter.		
WR_IMT	P3B Stream	'Acquisition complete'
Open shutter.		
ACQUIR		'Acquisition complete'
Close shutter.		
WR_IMT	P3B Stream	'Acquisition complete'
...		
Open shutter.		
ACQUIR		'Acquisition complete'
Close shutter.		
WR_IMT	P3B Stream	'Acquisition complete'
ENDSCN		'Scan ended'

Image tags

LONG	ExposureTime	Exposure time in ms
UINT	Binning	1,2 or 4
BYTE	Preview	Boolean
BYTE	AutoSave	Boolean
BYTE	SaveAOI	Boolean
STRING	Filepath	
BYTE	Flatfield	Boolean
BYTE	Background	Boolean
BYTE	WaitforTags	Boolean
FLOAT	Left	x coordinate of left side of AOI
FLOAT	Right	x coordinate of right side of AOI
FLOAT	Top	y coordinate of top side of AOI
FLOAT	Bottom	y coordinate of bottom side of AOI
FLOAT	XValue	Abscissa
FLOAT	MonoEnergy	Photon energy
...		
FLOAT	EPUPolarization	Mask position
FLOAT	EntranceSlit	Chopper position
...		
FLOAT	BeamCurrent	Ring current in mA.